

HAILSTORMS IN NEBRASKA.

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SYNOPSIS.

From a study of all available hailstorm records from one hundred and fifty cooperative Weather Bureau stations and the regular Weather Bureau stations in Nebraska it was found that the average number of hailstorms during the season April to September, inclusive, was 3.2. Hailstorms are most frequent in May and least frequent in September. The greatest number of hailstorms occur about a month later than the time of greatest rate of temperature increase in spring.

The greatest number of thunderstorms is in June and the fewest in April. Although hail does not occur without a thunderstorm, but 7.2 per cent of all thunderstorms is accompanied by hail. The percentage is largest in April and least in August.

Reports of hailstones as large as hens' eggs, or even larger, are frequent, and although storms of such intensity are local, they cause considerable damage.

In compiling the data for the following discussion the season includes only the six months April to September, inclusive, as this is the active growing season. The period October to March, inclusive, has been ignored, as there is but little or no vegetation to be damaged during this period, and consequently the number of hailstorms has but little effect upon agricultural interests.

No effort has been made to differentiate between storms of different intensity. The fact that a hailstorm has occurred does not necessarily mean that crops have been damaged in its path. The fall of hail may have been light and the hailstones small.

A careful study has been made of all available hail records from one hundred and fifty cooperative Weather Bureau stations scattered throughout Nebraska, together with the records kept at the regular Weather Bureau stations. In keeping the early records the value of complete hail data was not appreciated by many of the cooperative observers, and hailstorms were not recorded as carefully and as completely at the cooperative stations as has now been found desirable. For this reason it was found necessary to confine this discussion somewhat to the data recorded at the regular Weather Bureau stations. Data from numerous cooperative stations, however, were used in making the deductions, and it is gratifying to note the marked agreement between the records kept at the regular Weather Bureau stations and the records from such of the cooperative stations as had complete records.

Sioux City, Iowa, across the Missouri River from Nebraska, has been considered as representative of north-eastern Nebraska. The data from the Nebraska stations have been supplemented by data obtained from the records kept at the Weather Bureau station at Cheyenne, Wyoming. The data for Cheyenne have not, however, been considered in determining mean values.

The data in the tables cover the nineteen years 1901 to 1919, inclusive.

Average number of hailstorms each month.

Stations.	April.	May.	June.	July.	August.	September.	Seasonal.
Sioux City, Iowa.....	0.5	1.0	0.6	0.2	0.1	0.3	2.7
Omaha.....	0.8	1.1	0.5	0.2	0.1	0.4	3.1
Lincoln.....	0.8	0.7	0.5	0.4	0.4	0.3	3.1
York.....	0.8	1.1	0.6	0.2	0.2	0.2	3.1
Marquette.....	0.4	0.5	0.7	0.5	0.4	0.2	2.7
Genoa.....	0.4	0.8	0.5	0.4	0.2	0.1	2.5
Oakdale.....	0.4	0.9	1.2	0.4	0.3	0.4	3.6
Valentine.....	0.3	0.8	0.6	0.5	0.5	0.0	2.7
North Platte.....	0.4	0.8	0.5	0.6	0.5	0.1	2.9
Imperial.....	0.5	1.5	0.5	0.7	0.5	0.1	3.8
Kimball.....	0.1	0.7	1.9	0.9	0.8	0.2	4.6
Cheyenne, Wyo.....	0.5	1.5	2.6	1.3	1.2	0.9	8.0
Means.....	0.5	0.9	0.7	0.5	0.4	0.2	3.2

The above table gives the average number of hailstorms for each month, April to September, inclusive, and the total for the season, at selected stations throughout the State. It will be noticed that the greatest number of hailstorms is recorded during the spring months. For the State as a whole the maximum frequency is in May, with a gradual decrease until September, when the minimum occurs. Hailstorms occur with about the same frequency in April and July, which is a little more than half that for May.

In the eastern portion of the State the time of greatest frequency is May, becoming somewhat later as we go westward, and in the western portion more hailstorms occur in June than in any other month.

The fewest hailstorms occur generally in late summer and early autumn. Along the Missouri River the fewest storms are in August, becoming later to the westward, and in the central portion of the State the minimum number of storms is in September. In the western portion, however, fewer storms occur in April than in September. Note that during the 19 years a hailstorm has never been recorded at Valentine in September.

The total number of hailstorms for the season, taking the State as a whole, is 3.2. North of the Platte River the average is generally less than 3 storms each season, although there seems to be a small area, with Antelope County as the center, where there is an increase in frequency to an average of 3.6 hailstorms each season. South of the Platte River more than 3 storms are recorded each season. The number increases from 3.1 at the Missouri River on the east to about 3.8 in the southwestern corner of the State. There is also a rapid increase from 2.9 at North Platte to nearly 6.0 at the extreme western border of the State.

The accompanying table gives the change in mean temperature from the preceding month and shows the rapid increase in temperature during the period when hailstorms are most numerous.

Changes in monthly mean temperature.

Section of State.	March to April.	April to May.	May to June.	June to July.	July to August.	August to September.
Northeast.....	+12.2	+10.9	+ 9.3	+5.9	-2.2	-8.8
Southeast.....	+11.3	+10.5	+ 9.4	+6.0	-1.9	-8.6
Central.....	+11.3	+10.4	+ 9.7	+5.9	-1.9	-8.8
Southwest.....	+10.9	+ 9.8	+ 9.9	+6.0	-1.7	-8.8
West.....	+ 9.9	+ 9.2	+10.0	+6.2	-1.3	-9.3
Northwest.....	+11.1	+ 9.2	+10.5	+6.3	-1.8	-9.2
Means.....	+11.1	+10.0	+ 9.8	+6.0	-1.8	-8.9

For example, in the northeastern section of the State, April averages 12.2 degrees warmer than March; May, 10.9 degrees warmer than April; June, 9.3 degrees warmer than May; July, 5.9 degrees warmer than June; August, 2.2 degrees cooler than July; and September, 8.8 degrees cooler than August.

It will be noticed that the greatest increase in temperature is in April, while the greatest number of hailstorms is generally about a month later, or in May and June. This is what might be expected. The air near the earth's surface is warming rapidly in April, so that by the middle of May there is a large difference between the temperature of the air at the earth's surface and the air at a height of several miles. This is favorable for

strong convectional action, and as the formation of hail is dependent upon strong upward air currents, this period would be unusually favorable for the formation of hail.

From April there is a gradual decrease in the temperature increase for the State as a whole, and by August the change is a decrease in temperature. By referring to the table of hailstorms for each month it will be seen that there is a gradual decrease in the number of storms from May to August and September.

As hailstorms are an accompaniment of thunderstorms it is interesting to observe how many thunderstorms occur during the season.

Average number of thunderstorms each month.

Stations.	April.	May.	June.	July.	August.	September.	Seasonal.
Sioux City, Iowa.....	2.9	6.8	9.5	8.5	8.2	4.9	40.8
Omaha.....	3.6	7.6	9.7	8.6	8.5	5.7	43.7
Lincoln.....	3.8	7.2	10.1	9.9	9.2	6.3	46.5
York.....	3.7	8.6	11.3	10.8	11.5	6.0	51.9
Marquette.....	2.9	5.6	8.5	8.3	8.6	4.5	38.4
Oakdale.....	2.8	5.9	7.3	8.1	7.6	4.7	36.4
Valentine.....	1.4	4.9	9.4	8.4	8.6	3.8	36.5
North Platte.....	2.3	6.4	9.6	9.7	9.0	3.1	40.1
Cheyenne, Wyo.....	2.0	6.7	11.0	13.4	12.6	4.9	50.6
Means.....	2.7	6.6	9.4	9.0	8.9	4.9	41.8

For the State as a whole there is a gradual increase in the number of thunderstorms from April to June, and a decrease from June to September. June, July, and August, respectively, are the months of greatest frequency. There is a rapid decrease during September, and this month has a little more than half as many as August. The increase from April to May is rapid, more than twice as many thunderstorms occurring in May as in April.

In the eastern and northern portions of the State the month of greatest frequency is June. No set rule seems to apply to the remainder of the State. The period of maximum number of storms, however, is in one of the three months, June, July, or August, and seems to be a little later in the season in the central portion of the State than in the western. April is uniformly the month of fewest storms.

The total number of thunderstorms for the season, April to September, inclusive, varies from an average of 38 in the northern portion of the State to an average of 47 in the southern. In the northern portion there is a slight increase from 41 at the Missouri River to the westward, while in the southern portion there is an increase from 44 at the river to about 50 in the center of the State. Continuing westward there is a decrease to about 40, followed by an increase to about 50 at the western border of the State. The average number of storms for the State as a whole is about 42 each season.

As these tables indicate, all thunderstorms are not accompanied by hail. Some authorities state that from one-half to one-tenth of all thunderstorms are accompanied by hail. While this may be the case in some parts of the country, it does not hold true for Nebraska.

Percentage of thunderstorms accompanied by hail.

Stations.	April.	May.	June.	July.	August.	September.	Seasonal.
Sioux City, Iowa.....	16.1	14.6	6.1	2.5	3.7	5.4	6.6
Omaha.....	23.5	14.6	4.9	2.5	1.2	6.4	7.1
Lincoln.....	19.2	10.3	5.2	3.2	4.0	5.0	6.5
York.....	23.8	13.7	5.7	2.2	2.6	3.9	6.7
Marquette.....	13.5	8.8	8.5	6.7	4.5	3.7	7.1
Oakdale.....	14.8	15.9	15.8	5.2	4.2	7.9	10.0
Valentine.....	22.2	15.2	6.2	6.2	6.1	0.0	7.0
North Platte.....	15.9	12.4	4.9	6.0	5.8	1.7	6.9
Cheyenne, Wyo.....	26.3	21.9	23.1	9.8	9.6	18.1	15.7
Means.....	18.6	13.2	7.2	4.3	4.0	4.2	7.2

The above table gives the percentages of thunderstorms in Nebraska accompanied by hail in the different portions of the State. For the whole State, the greatest percentage is in April, when 18.6 per cent of all thunderstorms is accompanied by hail. As the season advances and thunderstorms become more frequent, the percentage is less, with a general decrease to August, when there is but 4 per cent. September has 4.2 per cent, or 0.2 per cent more than August.

Considering the State as a whole, 7.2 per cent of all thunderstorms is accompanied by hail. The lowest percentage seems to be in the southeastern portion of the State and the greatest in the western portion, with a secondary maximum in the central counties.

The general movement of hailstorms is from a westerly to an easterly direction. The path over which hail falls is usually of limited area. It is, in fact, quite common for the crops over but a small area to be damaged. This must not be misconstrued to mean, however, that this particular small area suffers loss year after year.

Hailstones of unusual size have been reported from various sections of the State. Authentic reports of hailstones as large as hens' eggs are not unusual, while occasionally hailstones even larger are reported. During a hailstorm at Stanton on April 25, 1893, the observer reported "hailstones 2 to 3 inches in diameter." At Madison a hailstone "3½ inches long" was reported by the cooperative observer during a storm on May 11, 1896. A hailstone "7½ inches in circumference" was reported at Hebron April 18, 1893, and one "7½ inches in circumference" at Nebraska City on September 5, 1898. The observer at Hayes Center entered on the official record for August 11, 1910, "Terrific hailstorm; hailstones 9 inches in circumference," and on May 31, 1900, noted "hailstones 2½ inches in diameter."

Hailstones of this size kill small animals and birds, literally pound the crops into the ground, strip small branches from trees, break windows, and even damage the walls and roofs of frame buildings. Great destruction is sometimes left in the path of such a storm. Fortunately, however, storms of this intensity are the exception rather than the rule in Nebraska.

LARGE HAILSTONES AT KANSAS CITY, MO., MAY 14, 1898.

At 7:25 p. m. hail began (the dividing line was about 75° zenith distance), the stones being of enormous size, rendering insignificant all previous records of hail at this station. The hail ended at 7:37 * * *. The official in charge measured between 15 and 20 of the largest hailstones and found them to range from 8 to 9½ inches in circumference. They were unusually well-formed and very solid. Quite a number were almost spherical; the majority were egg-shaped with one side rather flat. Very few had irregular surfaces or protuberances. The larger ones, when cut, showed 7 and 8 concentric layers outside the core. They were frozen hard, and a number of the heavier stones sank their depth in lawns and vacant ground.

The width of the hail belt was about 4 miles, but the very large hail was confined to this city, the area being little less than 3 square miles.

The damage by hail was very great. South windows and skylights were broken in nearly every house in the central and eastern portions of the city. Greenhouses suffered almost complete destruction. Horses, pelted by the hail, ran in every direction. Several persons were injured in one way or another. The roofs of buggies and carriages afforded no protection against such bombardment. Slates were broken on roofs. Fruit trees in the